

# Risk/PRG Evaluation of various Worker Scenarios at Hunter's Point Naval Shipyard

A risk assessment of the workers at Hunter's Point Naval Shipyard was performed to determine the risk associated with the release criteria specified in the Record of Decision (ROD). The release criteria in the ROD are specified in the following table:

Radionuclide	Surfaces			Soil <sup>d</sup> (pCi/g)				Water <sup>h</sup> (pCi/L)
	Equipment, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	Structures (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Residual Dose (mrem/yr) <sup>c</sup>	Outdoor Worker (pCi/g) <sup>e</sup>	Residual Dose (mrem/yr) <sup>c</sup>	Residential (pCi/g) <sup>e</sup>	Residual Dose (mrem/yr) <sup>c</sup>	
Americium-241	100	100	18.7	5.67	0.8661	1.36	24.84	15
Cesium-137	5,000	5,000	1.72	0.113	0.2142	0.113	0.2561	119
Cobalt-60	5,000	5,000	6.01	0.0602	0.5164	0.0361	0.3918	100
Europium-152	5,000	5,000	3.21	0.13 <sup>f</sup>	0.5018	0.13 <sup>f</sup>	0.502	60
Europium-154	5,000	5,000	3.49	0.23 <sup>f</sup>	0.9593	0.23 <sup>f</sup>	0.9599	200
Plutonium-239	100	100	18.1	14.0	1.743	2.59	1.138	15
Radium-226	100	100	0.612	1.0 <sup>g</sup>	6.342	1.0 <sup>g</sup>	14.59	5 <sup>i</sup>
Strontium-90	1,000	1,000	0.685	10.8	0.1931	0.331	1.648	8
Thorium-232	1,000	36.5	24.9	2.7	24.91	1.0 <sup>g</sup> 1.69	25	15
Tritium	5,000	5,000	0.00053	4.23	0.00179	2.28	0.05263	20,000
Uranium-235+D	5,000	488	25	0.398	0.178	0.195	0.8453	30

*Notes:*

<sup>a</sup> These limits are based on AEC *Regulatory Guide 1.86* (1974). Limits for removable surface activity are 20 percent of these values. *Risk 10<sup>-4</sup> @ 25 mrem/yr*

<sup>b</sup> These limits are based on 25 mrem/yr, using RESRAD-Build Version 3.3 or *Regulatory Guide 1.86*, whichever is lower.

<sup>c</sup> The resulting dose is based on modeling using RESRAD-Build Version 3.3 or RESRAD Version 6.3, with radon pathways turned off.

<sup>d</sup> EPA PRGs for two future-use scenarios.

<sup>e</sup> The on-site and off-site laboratory will ensure that the MDA meets the listed release criteria by increasing sample size or counting time as necessary. The MDA is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDA is calculated per sample by considering background counts, amount of sample used, and counting time.

To ensure that worker's risk to soil concentrations is within EPA's acceptable risk range, a risk assessment for various worker scenarios was evaluated. The various worker scenarios included an indoor worker, an outdoor worker, and a construction worker. The following paragraphs outlines the specific parameters used when evaluating the risk for each scenario. The outputs for each worker scenario include a table listing the specific Preliminary Remediation Goal (PRG) value for each radionuclide. The PRG value corresponds to the concentration at which the risk would be 10<sup>-4</sup>. In addition, a risk value table is given for each radionuclide at the release criteria specified in the above ROD for each worker scenario.

## Indoor worker

The indoor worker, the receptor, has been described in the PRG user's manual, as the following:

"This receptor spends most, if not all, of the workday indoors. Thus, an indoor worker has no direct contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of contaminated soils that have been incorporated into indoor dust, external radiation from contaminants in soil, and the inhalation of contaminants present in indoor air. PRGs calculated for this receptor are expected to be protective of both workers engaged in low intensity activities such as office work and those engaged in more strenuous activity (e.g., factory or warehouse workers)."

In addition, the visual below depicts the indoor worker scenario at a site where residual contamination exists (in pink):



When considering site specific parameters, the following inputs were used for performing the risk assessment in the PRG calculator:

The contaminants of concern would be at most the concentrations specified in the ROD for soil which include:

Radionuclide	Concentration (pCi/g)
Am-241	1.36
Cs-137	0.113
Co-60	0.0361
Eu-152	0.13
Eu-154	0.23
Pu-239	2.59
Ra-226	1.0
Sr-90	0.331
Th-232	1.69
H-3	2.28
U-235	0.195

The assumptions made for the indoor worker is that the worker is at indoor at work 8 hours per day for 250 days per year over 25 years. The residual contamination is directly underneath the foundation. No clean soil is under the foundation. The foundation shields external gamma radiation by a factor is 0.4, also known as the gamma shielding factor. The location of the building is within San Francisco area, roughly 428 acres, and the vegetation on-site is roughly 50% of the entire site. The indoor worker soil intake rate is 50mg per day.

To be outside of the acceptable risk range of  $10^{-4}$ , the values listed in the ROD table would have to exceed the listed PRG value listed below. Each PRG value is broken out into ingestion limits, inhalation limits, external gamma limit, and then a total of all of the pathways for each radionuclide.

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
<i>*Secular Equilibrium PRG for Am-241</i>	5.77E+02	1.00E+04	2.17E+01	2.09E+01
<i>*Secular Equilibrium PRG for Co-60</i>	4.37E+04	3.24E+07	3.54E+00	3.54E+00
<i>*Secular Equilibrium PRG for Cs-137</i>	1.01E+04	2.89E+07	1.73E+01	1.72E+01
<i>*Secular Equilibrium PRG for Eu-152</i>	1.31E+04	3.76E+05	8.10E+00	8.10E+00
<i>*Secular Equilibrium PRG for Eu-154</i>	7.09E+04	1.58E+07	7.49E+00	7.49E+00
<i>*Secular Equilibrium PRG for H-3</i>	-	1.61E+01	-	1.61E+01
<i>*Secular Equilibrium PRG for Pu-239</i>	4.77E+02	8.80E+03	1.88E+01	1.80E+01
<i>*Secular Equilibrium PRG for Ra-226</i>	1.37E+02	5.50E+04	5.23E+00	5.04E+00
<i>*Secular Equilibrium PRG for Sr-90</i>	5.45E+03	7.50E+06	2.25E+03	1.59E+03
<i>*Secular Equilibrium PRG for Th-232</i>	3.49E+02	1.41E+04	3.85E+00	3.81E+00
<i>*Secular Equilibrium PRG for U-235</i>	5.82E+02	1.04E+04	1.88E+01	1.82E+01

The following table determine the risk for each of the radionuclides in the ROD assuming the scenario listed above for indoor worker. The risk for each pathway including ingestion, inhalation, and external exposure is shown in the table as well as a total risk for all pathways. If all the radionuclides are present at the site in each location at the same given time (this is not realistic to site conditions), the total risk is still within EPA's risk range of  $10^{-6}$  to  $10^{-4}$ .

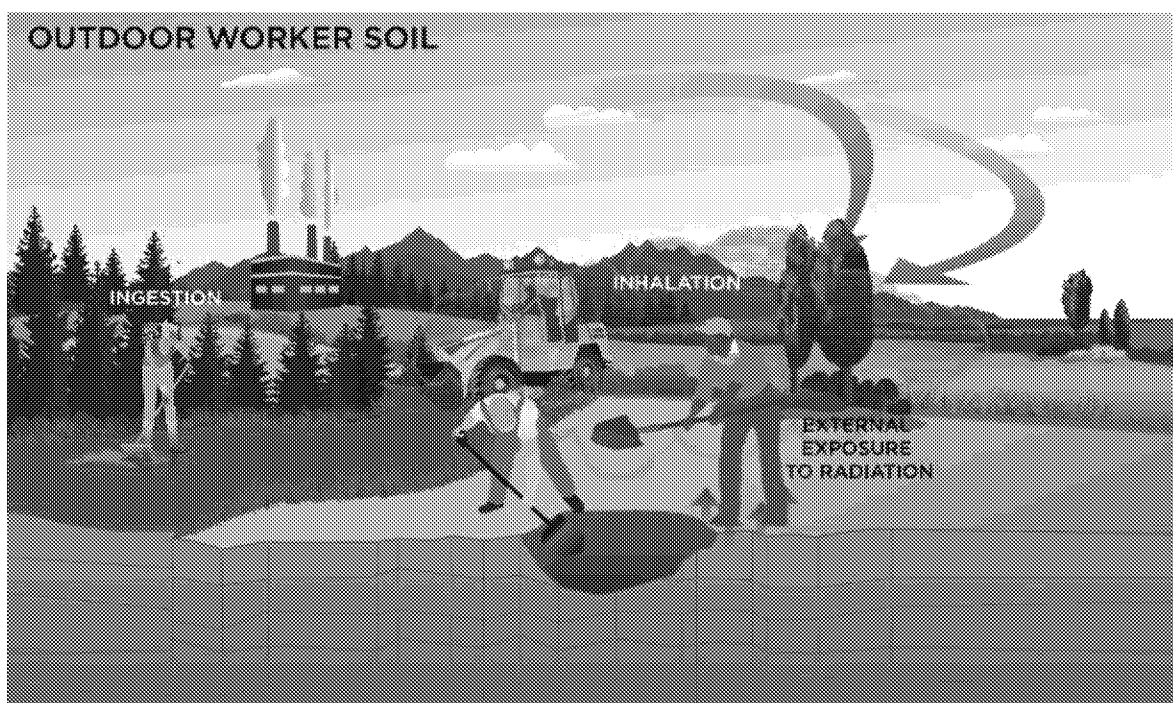
Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
<i>*Secular Equilibrium Risk for Am-241</i>	2.36E-07	1.35E-08	6.27E-06	<b>6.52E-06</b>
<i>*Secular Equilibrium Risk for Co-60</i>	8.26E-11	1.12E-13	1.02E-06	<b>1.02E-06</b>
<i>*Secular Equilibrium Risk for Cs-137</i>	1.12E-09	3.90E-13	6.54E-07	<b>6.55E-07</b>
<i>*Secular Equilibrium Risk for Eu-152</i>	9.93E-10	3.46E-11	1.60E-06	<b>1.61E-06</b>
<i>*Secular Equilibrium Risk for Eu-154</i>	3.24E-10	1.46E-12	3.07E-06	<b>3.07E-06</b>
<i>*Secular Equilibrium Risk for H-3</i>	-	1.42E-05	-	<b>1.42E-05</b>
<i>*Secular Equilibrium Risk for Pu-239</i>	5.43E-07	2.94E-08	1.38E-05	<b>1.44E-05</b>
<i>*Secular Equilibrium Risk for Ra-226</i>	7.29E-07	1.82E-09	1.91E-05	<b>1.98E-05</b>
<i>*Secular Equilibrium Risk for Sr-90</i>	6.07E-09	4.41E-12	1.47E-08	<b>2.08E-08</b>
<i>*Secular Equilibrium Risk for Th-232</i>	4.85E-07	1.20E-08	4.39E-05	<b>4.44E-05</b>
<i>*Secular Equilibrium Risk for U-235</i>	3.35E-08	1.88E-09	1.04E-06	<b>1.07E-06</b>
<i>*Total Risk</i>	2.03E-06	1.43E-05	9.05E-05	<b>1.07E-04</b>

## Outdoor Worker

The outdoor worker, the receptor, has been described in the PRG user's manual, as the following:

"This is a long-term receptor exposed during the work day who is a full time employee working on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposures to surface soils. The outdoor worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, external radiation from contaminants in soil, inhalation of fugitive dust. The outdoor worker receives more exposure than the indoor worker under commercial/industrial conditions."

In addition, the visual below depicts the outdoor worker scenario at a site where residual contamination exists (in pink):



The assumptions made for the outdoor worker is that the worker is at outdoor at work for 8 hours per day for 225 days per year over 25 years. The residual contamination is directly underneath a cap and/or asphalt at the site that relates to roughly 20 cm of soil. The The foundation shields external gamma radiation by a factor is 0.4, also known as the gamma shielding factor. The location of the site is within San Francisco area, roughly 428 acres, and the vegetation on-site is roughly 50% of the entire site. The indoor worker soil intake rate is 100mg per day and the worker's inhalation rate is 60m<sup>3</sup>/day.

To be outside of the acceptable risk range of  $10^{-4}$ , the values listed in the ROD table would have to exceed the listed PRG value listed below. Each PRG value is broken out into ingestion limits, inhalation limits, external gamma limit, and then a total of all of the pathways for each radionuclide.

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
*Secular Equilibrium PRG for Am-241	3.20E+02	1.12E+04	1.90E+02	1.18E+02
*Secular Equilibrium PRG for Co-60	2.43E+04	3.59E+07	1.21E+01	1.21E+01
*Secular Equilibrium PRG for Cs-137	5.59E+03	3.22E+07	9.36E+01	9.21E+01
*Secular Equilibrium PRG for Eu-152	7.28E+03	4.18E+05	3.27E+01	3.26E+01
*Secular Equilibrium PRG for Eu-154	3.94E+04	1.76E+07	3.03E+01	3.02E+01
*Secular Equilibrium PRG for H-3	-	1.78E+01	-	1.78E+01
*Secular Equilibrium PRG for Pu-239	2.65E+02	9.78E+03	2.12E+02	1.16E+02
*Secular Equilibrium PRG for Ra-226	7.62E+01	6.12E+04	1.94E+01	1.54E+01
*Secular Equilibrium PRG for Sr-90	3.03E+03	8.34E+06	2.70E+04	2.72E+03
*Secular Equilibrium PRG for Th-232	1.94E+02	1.56E+04	9.81E+00	9.33E+00
*Secular Equilibrium PRG for U-235	3.23E+02	1.15E+04	2.12E+02	1.27E+02

The following table determine the risk for each of the radionuclides in the ROD assuming the scenario listed above for the outdoor worker. The risk for each pathway including ingestion, inhalation, and external exposure is shown in the table as well as a total risk for all pathways. If all the radionuclides are present at the site in each location at the same given time (this is not realistic to site conditions), the total risk is still within EPA's risk range of  $10^{-6}$  to  $10^{-4}$ .

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
*Secular Equilibrium Risk for Am-241	4.24E-07	1.22E-08	7.17E-07	1.15E-06
*Secular Equilibrium Risk for Co-60	1.49E-10	1.00E-13	2.98E-07	2.99E-07
*Secular Equilibrium Risk for Cs-137	2.02E-09	3.51E-13	1.21E-07	1.23E-07
*Secular Equilibrium Risk for Eu-152	1.79E-09	3.11E-11	3.97E-07	3.99E-07
*Secular Equilibrium Risk for Eu-154	5.84E-10	1.31E-12	7.60E-07	7.61E-07
*Secular Equilibrium Risk for H-3	-	1.28E-05	-	1.28E-05
*Secular Equilibrium Risk for Pu-239	9.77E-07	2.65E-08	1.22E-06	2.23E-06
*Secular Equilibrium Risk for Ra-226	1.31E-06	1.63E-09	5.16E-06	6.47E-06
*Secular Equilibrium Risk for Sr-90	1.09E-08	3.97E-12	1.23E-09	1.22E-08
*Secular Equilibrium Risk for Th-232	8.72E-07	1.08E-08	1.72E-05	1.81E-05
*Secular Equilibrium Risk for U-235	6.03E-08	1.70E-09	9.21E-08	1.54E-07
*Total Risk	3.66E-06	1.28E-05	2.60E-05	4.25E-05

## Construction Worker

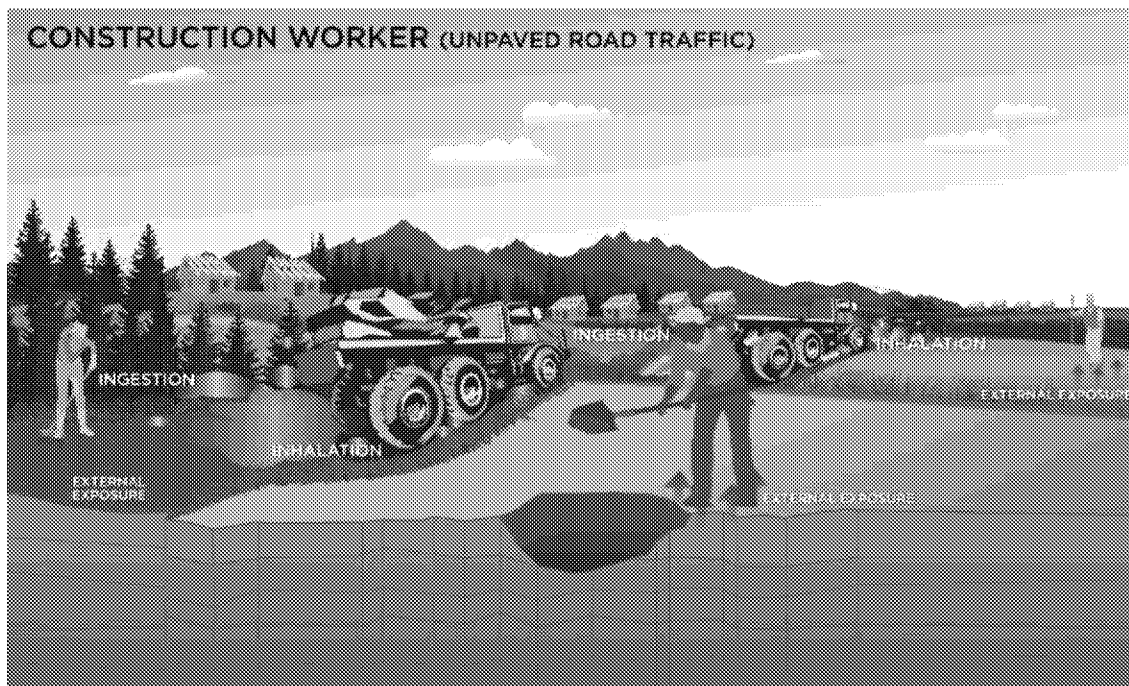
The construction worker scenario is broken down into two activities: the unpaved road traffic activities and the other construction activities. The difference between the two activities is how the particle emission factor (PEF) is calculated using specified input parameters. See Attachment for a simplified flowchart of specific input parameters. The following paragraphs describes each of these activities.

### Unpaved Road Traffic Activities

The construction worker, also known as the receptor, involved with unpaved traffic road activities has been described in the PRG user's manual, as the following:

“This is a short-term receptor exposed during the work day working around vehicles suspending dust in the air. The activities for this receptor (e.g., trenching, excavating) typically involve on-site exposures to surface soils. The construction worker is expected to have an elevated soil ingestion rate (330 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, external radiation from contaminants in soil, inhalation of fugitive dust.”

In addition, the visual below depicts the construction worker scenario involved with unpaved road traffic activities at a site where residual contamination exists (in pink):



The assumptions made for the construction worker is that the worker is at outdoor at work for 8 hours per day for 250 days per year for 1 year. The activities for this receptor include trenching and excavation. There is no cap or clean soil on top of the residual contamination. The vehicles that contribute to the particle emission factor are cars and trucks located on unpaved roads. Ten total cars

are onsite at a time that weigh roughly 2 ton. Ten large trucks are also on site at any given time that weigh 45 ton. These vehicles are assumed to travel 4317.8 linear feet (default value) on unpaved road ways that are 20 feet wide (default value). The location of the site is within San Francisco area which rains 68 days per year, the site is roughly 428 acres, and no vegetation on the entire site (default value). The construction worker soil ingestion rate is 330mg per day and the soil inhalation rate is 60m<sup>3</sup>/day.

To be outside of the acceptable risk range of 10<sup>-4</sup>, the values listed in the ROD table would have to exceed the listed PRG value listed below. Each PRG value is broken out into ingestion limits, inhalation limits, external gamma limit, and then a total of all of the pathways for each radionuclide.

Isotope	Ingestion PRG TR=1.0E-4 (pCi/g)	Inhalation PRG TR=1.0E-4 (pCi/g)	External Exposure PRG TR=1.0E-4 (pCi/g)	Total PRG TR=1.0E-4 (pCi/g)
<i>*Secular Equilibrium PRG for Am-241</i>	2.19E+03	3.66E+01	2.17E+02	<b>3.09E+01</b>
<i>*Secular Equilibrium PRG for Co-60</i>	1.65E+05	1.18E+05	3.54E+01	<b>3.54E+01</b>
<i>*Secular Equilibrium PRG for Cs-137</i>	3.81E+04	1.06E+05	1.73E+02	<b>1.72E+02</b>
<i>*Secular Equilibrium PRG for Eu-152</i>	4.96E+04	1.37E+03	8.10E+01	<b>7.64E+01</b>
<i>*Secular Equilibrium PRG for Eu-154</i>	2.69E+05	5.76E+04	7.49E+01	<b>7.48E+01</b>
<i>*Secular Equilibrium PRG for H-3</i>	-	4.01E+02	-	<b>4.01E+02</b>
<i>*Secular Equilibrium PRG for Pu-239</i>	1.81E+03	3.21E+01	1.88E+02	<b>2.70E+01</b>
<i>*Secular Equilibrium PRG for Ra-226</i>	5.19E+02	2.01E+02	5.23E+01	<b>3.84E+01</b>
<i>*Secular Equilibrium PRG for Sr-90</i>	2.06E+04	2.74E+04	2.25E+04	<b>7.73E+03</b>
<i>*Secular Equilibrium PRG for Th-232</i>	1.32E+03	5.13E+01	3.85E+01	<b>2.16E+01</b>
<i>*Secular Equilibrium PRG for U-235</i>	2.21E+03	3.77E+01	1.88E+02	<b>3.10E+01</b>

The following table determine the risk for each of the radionuclides in the ROD assuming the scenario listed above for indoor worker. The risk for each pathway including ingestion, inhalation, and external exposure is shown in the table as well as a total risk for all pathways. If all the radionuclides are present at the site in each location at the same given time (this is not realistic to site conditions), the total risk is still within EPA's risk range of 10<sup>-6</sup> to 10<sup>-4</sup>.

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
<i>*Secular Equilibrium Risk for Am-241</i>	6.22E-08	3.71E-06	6.27E-07	<b>4.40E-06</b>
<i>*Secular Equilibrium Risk for Co-60</i>	2.18E-11	3.06E-11	1.02E-07	<b>1.02E-07</b>
<i>*Secular Equilibrium Risk for Cs-137</i>	2.96E-10	1.07E-10	6.54E-08	<b>6.58E-08</b>
<i>*Secular Equilibrium Risk for Eu-152</i>	2.62E-10	9.48E-09	1.60E-07	<b>1.70E-07</b>
<i>*Secular Equilibrium Risk for Eu-154</i>	8.57E-11	3.99E-10	3.07E-07	<b>3.08E-07</b>
<i>*Secular Equilibrium Risk for H-3</i>	-	5.68E-07	-	<b>5.68E-07</b>
<i>*Secular Equilibrium Risk for Pu-239</i>	1.43E-07	8.07E-06	1.38E-06	<b>9.60E-06</b>
<i>*Secular Equilibrium Risk for Ra-226</i>	1.93E-07	4.98E-07	1.91E-06	<b>2.60E-06</b>
<i>*Secular Equilibrium Risk for Sr-90</i>	1.60E-09	1.21E-09	1.47E-09	<b>4.28E-09</b>
<i>*Secular Equilibrium Risk for Th-232</i>	1.28E-07	3.30E-06	4.39E-06	<b>7.81E-06</b>
<i>*Secular Equilibrium Risk for U-235</i>	8.84E-09	5.17E-07	1.04E-07	<b>6.29E-07</b>
<i>*Total Risk</i>	5.37E-07	1.67E-05	9.05E-06	<b>2.63E-05</b>



### Other Construction Activities

The construction worker, also known as the receptor, involved with other construction activities besides unpaved traffic road activities has been described in the PRG user's manual, as the following:

“This is a short-term receptor exposed during the work day working around heavy vehicles suspending dust in the air. The activities for this receptor (e.g., dozing, grading, tilling, dumping, excavating) typically involve on-site exposures to surface soils. The construction worker is expected to have an elevated soil ingestion rate (330 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, external radiation from contaminants in soil, inhalation of fugitive dust.”

In addition, the visual below depicts the construction worker scenario involved with activities besides unpaved road traffic activities at a site where residual contamination exists (in pink):



The assumptions made for the construction worker is that the worker is at outdoor at work for 8 hours per day for 250 days per year for 1 year. There is no cap or clean soil on top of the residual contamination. Specific construction activities including dozing, grading, tilling, dumping, and excavation contribute to the particle emission factor. All activities were assumed to encompass the entire site of 428 acres with a depth of excavation was 40 feet (the depth of utilities). In addition, each activity took twice to perform. The dozer blade was assumed to be 8 meters, and the grading blade was assumed to be 8 meters, as well. The location of the site is within San Francisco area which rains 68 days per year,

the site is roughly 428 acres, and no vegetation on the entire site (default value). The construction worker soil ingestion rate is 330mg per day and the soil inhalation rate is 60m<sup>3</sup>/day.

To be outside of the acceptable risk range of 10<sup>-4</sup>, the values listed in the ROD table would have to exceed the listed PRG value listed below. Each PRG value is broken out into ingestion limits, inhalation limits, external gamma limit, and then a total of all of the pathways for each radionuclide.

Isotope	Ingestion PRG TR=1.0E-4 (pCi/g)	Inhalation PRG TR=1.0E-4 (pCi/g)	External Exposure PRG TR=1.0E-4 (pCi/g)	Total PRG TR=1.0E-4 (pCi/g)
<i>*Secular Equilibrium PRG for Am-241</i>	2.19E+03	1.05E+03	2.17E+02	<b>1.66E+02</b>
<i>*Secular Equilibrium PRG for Co-60</i>	1.65E+05	3.38E+06	3.54E+01	<b>3.54E+01</b>
<i>*Secular Equilibrium PRG for Cs-137</i>	3.81E+04	3.03E+06	1.73E+02	<b>1.72E+02</b>
<i>*Secular Equilibrium PRG for Eu-152</i>	4.96E+04	3.93E+04	8.10E+01	<b>8.07E+01</b>
<i>*Secular Equilibrium PRG for Eu-154</i>	2.69E+05	1.65E+06	7.49E+01	<b>7.48E+01</b>
<i>*Secular Equilibrium PRG for H-3</i>	-	4.01E+02	-	<b>4.01E+02</b>
<i>*Secular Equilibrium PRG for Pu-239</i>	1.81E+03	9.20E+02	1.88E+02	<b>1.44E+02</b>
<i>*Secular Equilibrium PRG for Ra-226</i>	5.19E+02	5.76E+03	5.23E+01	<b>4.71E+01</b>
<i>*Secular Equilibrium PRG for Sr-90</i>	2.06E+04	7.85E+05	2.25E+04	<b>1.06E+04</b>
<i>*Secular Equilibrium PRG for Th-232</i>	1.32E+03	1.47E+03	3.85E+01	<b>3.65E+01</b>
<i>*Secular Equilibrium PRG for U-235</i>	2.21E+03	1.08E+03	1.88E+02	<b>1.49E+02</b>

The following table determine the risk for each of the radionuclides in the ROD assuming the scenario listed above for indoor worker. The risk for each pathway including ingestion, inhalation, and external exposure is shown in the table as well as a total risk for all pathways. If all the radionuclides are present at the site in each location at the same given time (this is not realistic to site conditions), the total risk is still within EPA's risk range of 10<sup>-6</sup> to 10<sup>-4</sup>.

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
<i>*Secular Equilibrium Risk for Am-241</i>	6.22E-08	1.29E-07	6.27E-07	<b>8.19E-07</b>
<i>*Secular Equilibrium Risk for Co-60</i>	2.18E-11	1.07E-12	1.02E-07	<b>1.02E-07</b>
<i>*Secular Equilibrium Risk for Cs-137</i>	2.96E-10	3.73E-12	6.54E-08	<b>6.57E-08</b>
<i>*Secular Equilibrium Risk for Eu-152</i>	2.62E-10	3.30E-10	1.60E-07	<b>1.61E-07</b>
<i>*Secular Equilibrium Risk for Eu-154</i>	8.57E-11	1.39E-11	3.07E-07	<b>3.07E-07</b>
<i>*Secular Equilibrium Risk for H-3</i>	-	5.68E-07	-	<b>5.68E-07</b>
<i>*Secular Equilibrium Risk for Pu-239</i>	1.43E-07	2.81E-07	1.38E-06	<b>1.80E-06</b>
<i>*Secular Equilibrium Risk for Ra-226</i>	1.93E-07	1.74E-08	1.91E-06	<b>2.12E-06</b>
<i>*Secular Equilibrium Risk for Sr-90</i>	1.60E-09	4.22E-11	1.47E-09	<b>3.12E-09</b>
<i>*Secular Equilibrium Risk for Th-232</i>	1.28E-07	1.15E-07	4.39E-06	<b>4.63E-06</b>
<i>*Secular Equilibrium Risk for U-235</i>	8.84E-09	1.80E-08	1.04E-07	<b>1.31E-07</b>
<i>*Total Risk</i>	5.37E-07	1.13E-06	9.05E-06	<b>1.07E-05</b>

## Conclusion

Four scenarios were evaluated at Hunter's Point Naval Shipyard: Indoor worker, Outdoor Worker, Construction Worker involved with unpaved traffic road activities, and Construction Worker involved with other activities besides unpaved traffic road activities. Based on all four scenarios for worker risk to the radionuclides present, all PRG values (i.e. maximum values that would exceed the risk of  $10^{-4}$ ) were greater than the concentrations listed in the ROD. When specifically evaluating the release criteria values listed in the ROD, the risk for each radionuclide, including a combination of all radionuclides, were well below EPA's acceptable risk. The work performed at Hunter's Point does not pose any risk to workers in the scenarios listed above for concentrations below the release criteria listed in the ROD.

## Attachment: Simplified Flowchart of Construction Worker Scenario Inputs

